Reviewer's Report for:

Assessment of NMFS' Draft Biological Opinion on the Bureau of Reclamation's Klamath Project Operation

Prepared by

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Executive summary:

1. This review was undertaken to evaluate and comment on the use of the best available scientific and commercial information in the National Marine Fisheries Service (NMFS) 'Draft Biological Opinion on Bureau of Reclamation's Klamath Project Operations 2008-2018' (KPO-BiOp).

2. The seven questions posed in the Terms of Reference arose from previous reviews of NMFS' Biological Opinions by CalFed Bay-Delta Authority Science Program (Cal-Fed) and the Center for Independent Experts reviewers, as drawn together by NMFS' Science Centre (Lindley *et al.*, 2006). Summary conclusions to these questions are shown below.

3. *Does the draft biological opinion incorporate an ecological framework that emphasizes the geographic structure of habitats, populations, and diverse salmon life histories that contribute to salmon resilience and productivity (i.e., Viable Salmon Population (VSP) concept, see McElhaney et al., 2000 and Lindley et al., 2006)?*
   The KPO-BiOp does utilize ecological frameworks that demonstrates the geographic structure of habitats, populations, and salmon life histories and relates these to the key parameters that define VSP. However, while this framework should provide a clear and sound basis for evaluating the potential impacts of the Project, its clarity must also depend on providing a clear account of the linkages as the different factors are discussed, and this is not always apparent within the KPO-BiOp

4. *Does the draft biological opinion consider a range of climatological conditions and water demand scenarios in the analysis?*
   The KPO-BiOp makes it clear that both climatological changes and increased water demand pose significant risks to the future viability coho salmon population units in the Klamath River Basin. The report also indicates that changes in climatological conditions and water demand are likely in the coming years. However, the BiOp does not present alternative climatic options or quantify future changes in water use and does not consider a range of climatological conditions and water demand scenarios in the analysis or in the assessment of the Project.

5. *Does the draft biological opinion consider a range of ocean conditions in the analysis?*
   Although the KPO-BiOp acknowledges the role of ocean conditions in affecting the viability of coho salmon population units with the Klamath River and notes the potential interactions with other factors, it does not consider a range of ocean conditions in the analysis.

6. *Does the draft biological opinion consider the effects of hatchery fish on listed fish?*
   The KPO-BiOp does consider the effects of hatchery fish on the Klamath River Population Units, but there is lack of clarity about the objectives of the hatchery programs and the role of hatchery fish within the ESU. There are a number of inconsistencies in the information provided about hatchery reared fish, including the appropriate or desired level of hatchery rearing, the behavior of wild versus hatchery smolts and the effects of hatchery fish on key VSP parameters. Given the clear desire to restore natural coho salmon populations, and the risks posed by hatchery fish, further consideration should be given to the potential beneficial effects of substantially modifying the releases of hatchery reared fish.

7. *Did NMFS' draft biological opinion present convincing scientific evidence about the spatial and temporal extent of young-of-year and juvenile coho salmon use and occurrence in the mainstem Klamath River?*
   Information on the distribution on fry and parr in the mainstem Klamath River is clearly very sparse. As a result the KPO-BiOp relies heavily on a habitat simulation approach (Hardy *et al.* 2006) to determine the distribution of suitable habitat for these life-stages and to thereby estimate the impacts of the Project. While this approach is consistent with using the best available scientific information, it clearly adds significantly to the uncertainty. This therefore needs to be made more explicit, and greater effort must be made to remove inconsistencies in the report.

8. *Has the draft biological opinion adequately evaluated the potential effects of mainstem flows on the survivorship of coho smolts?*
   The KPO-BiOp contains specific Sections describing hydrological effects on smolts in different Klamath River Reaches, but relatively little information is provided in some of these Sections and some of it appears to be contradictory. Since smolt outmigration is clearly a critical phase in the coho salmon lifecycle, it requires more detailed evaluation.

9. *Are the draft biological opinion's scientific findings on the influence of mainstem flows on the spatial and temporal extent of coho juvenile survivorship in the summer months scientifically supportable?*
   Information on the spatial and temporal distribution of juvenile salmon in the mainstem Klamath River is very limited and, as discussed in other sections, has largely had to be inferred from simulation modeling of suitable habitat. While this provides a basis for assessing the possible effects of different flow conditions on juvenile coho survival, the full effects of different flow regimes on the quantity and quality of available habitat have not been fully assessed or clearly presented.

1 Background

The purpose of the review is to evaluate and comment on the use of the best available scientific and commercial information in the National Marine Fisheries Service (NMFS) 'Draft Biological Opinion on Bureau of Reclamation's Klamath Project Operations 2008-2018' (KPO-BiOp). This biological opinion considers the effects of the Bureau of Reclamation's (Reclamation) Klamath Project Operations (the Project) on the listed threatened Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*) and its designated critical habitat for the period 2008 to 2018. As instructed in the Statement of Work (SOW) (Annex 1), the review focuses on the technical aspects of the KPO-BiOp and does not consider whether NMFS's conclusions regarding the Project's potential to adversely modify or destroy critical habitat or jeopardize the continued existence or recovery of listed SONCC coho salmon are correct.

Due to water limitation to meet all the needs of humans, wildlife and fisheries resources, NMFS's 2001 and 2002 biological opinions on the effects of the Project, including water supplies to the Klamath Irrigation Project, have been subject to intense scrutiny and litigation. NMFS therefore sought a review from the National Academies Committee on Endangered and Threatened Fishes in the Klamath River Basin (NRC) on the strength of scientific support for the biological assessment and biological opinion. The NRC's interim report included the following conclusions, and these were confirmed in their final report on the NMFS's 2002 biological opinion:

- A lack of evidence indicating mainstem flows influences coho year class strength;
- The relative increase in available habitat for coho salmon in the mainstem Klamath River resulting from higher flows required an NMFS' Reasonable and Prudent Alternative to the Proposed Action were minor;
- A lack of scientific evidence in the Klamath River of a positive relationship between mainstem Klamath River flows and coho smolt survival; and
- Higher summer flows could be disadvantageous by further increasing water temperature and reducing thermal refugial habitat in the mainstem Klamath River.

NMFS also sought a peer review on its Central Valley Project and State Water Project Operations, Criteria and Plan Biological Opinion (OCAP-BiOp) from the CalFed Bay-Delta Authority Science Program (Cal-Fed) and the Center for Independent Experts (CIE). The NMFS's Science Centre then consolidated these reviews to develop recommendations and guidance for the development of future NMFS biological opinions (Lindley *et al.* 2006). The NRC and Science Centre Reviews provide the background for the Terms of Reference (ToR) to this review.

The itemized tasks for this review are specified as follow:

1. Read "NMFS' Draft Biological Opinion on Bureau of Reclamation's Klamath Project Operations 2008-2018" with a focus on the effects analysis.

2. Consider additional scientific information as necessary.

3. Conduct an independent peer review and complete an independent peer-review report addressing each task in accordance to the Terms of Reference with a copy each sent

to Dr. David Die at ddie@rsmas.miami.edu and Mr. Manoj Shivlani at shivlanim@bellsouth.net.

2 Terms of Reference

As stated in the SOW, the ToR for this review are as follows:

"CIE reviewers shall evaluate the draft Opinion [KPO-BiOp] to determine whether the following questions resulting from the Science Center review [Lindley *et al.*, 2006] are adequately addressed:

1. Does the draft biological opinion incorporate an ecological framework that emphasizes the geographic structure of habitats, populations, and diverse salmon life histories that contribute to salmon resilience and productivity (*i.e.*, VSP concept, see McElhany *et al.*, 2000 and Lindley *et al.*, 2006)?
2. Does the draft biological opinion consider a range of climatological conditions and water demand scenarios in the analysis?
3. Does the draft biological opinion consider a range of ocean conditions in the analysis?
4. Does the draft biological opinion consider the effects of hatchery fish on listed fish?

Additionally, CIE reviewers shall evaluate the draft biological opinion to determine whether the following questions resulting from the NRC's 2002 and 2004 reports are adequately addressed:

5. Did NMFS' draft biological opinion present convincing scientific evidence about the spatial and temporal extent of young-of-year and juvenile coho salmon use and occurrence in the mainstem Klamath River?
6. Has the draft biological opinion adequately evaluated the potential effects of mainstem flows on the survivorship of coho smolts?
7. Are the draft biological opinion's scientific findings on the influence of mainstem flows on the spatial and temporal extent of coho juvenile survivorship in the summer months scientifically supportable?"

3 Description of Review Activities

I have undertaken this review as a desk exercise based at the Cefas Lowestoft Laboratory, England.

The CIE provided, by email, a copy of the report to be reviewed:

- NMFS (2008) Draft Biological Opinion on Bureau of Reclamation's Klamath Project Operations 2008-2018, 187pp. [KPO-BiOp]

The CIE also provided copies of:

- Endangered Species Act of 1973. Department of the Interior, US Fish and Wildlife Service. 41pp.

- Section 7 Interagency Co-operation Implementation Regulation (50 CFR §402) (1986). 19pp.
- Lindley, S., Legault, C., Mundy, P., Murphy, J., and Waples, R. (2006) NMFS Science Center Evaluation of the Peer Reviews of the Long-term Central valley Project and State Water Project Operations Section 7 Consultation. 16pp.
- McElhany, P., Rucklelshaus, M.H., Ford, M.J., Wainwright, T.C., and Bjokstedt, E.P. (2000) Viable Salmonid Populations and the recovery of Evolutionary Significant Units. NOAA Technical Memorandum. NMFS –NWFSC-42. 127pp.
- Ruvelas, P. Consultation under the Endangered Species Act. Pfd copy of PowerPoint presentation. 11pp.

I have read and fully considered these documents as a basis for answering the questions in the ToR.

I have obtained additional reference material from personal sources and the internet as required. The BiOp relies heavily on other, principally grey, literature not all of which is included in the reference list. However, the nature of the questions in the ToR indicates an expectation that the KPO-BiOp should stand alone, and I have completed the assessment on this basis. It should be noted, however, that it is not clear whether all the key reports cited in the BiOp have themselves been subject to peer-review; thus, for example, the report by Williams *et al.* (2007), which is a key reference within the KPO-BiOp, states (p.3), '*As a review draft, this document should not be cited; the report will be published in an appropriate venue when completed'*.

According to the Schedule of Milestones and Deliverables, the pre-review documents were due to be supplied to the CIE Reviewers on 5th March, 2008. In the event, the background documents for the review were made available on 12th March and the Draft Biological Opinion was supplied on 4th April 2008. As a result the submission of this review has also been delayed, and a revised submission date of 21st April was agreed with the CIE Program Manager.

4 Analyses and comments

In this section I examine each of the seven questions posed in the ToR. In the case of questions 'a' to 'd', I look first at the context in which the question was posed, in particular with reference to Lindley *et al.* (2006) and the Viable Salmonid Population (VSP) report (McElhany *et al.*, 2000).

Lindley *et al.* (2006) reviewed the peer reviews of NMFS' OACP-BiOp. One peer review was implemented by Cal-Fed resulting in the consensus report of a group of six scientists, and a second was implemented by NMFS through CIE, which provided reports from two reviewers. Questions 'a' to'd' appear to relate specifically to issues raised in those reviews.

Questions 'e' to 'g' result from NRC reports published in 2002 and 2004. These reports are cited in the NMFS' KPO-BiOp but are not listed in the references and have not been made available to the CIE reviewers. As a result no further information is available on the basis of these questions.

a. Does the draft biological opinion incorporate an ecological framework that emphasizes the geographic structure of habitats, populations, and diverse salmon life histories that contribute to salmon resilience and productivity (*i.e.*, VSP concept, see McElhaney *et al.*. 2000 and Lindley *et al.*. 2006)?

The wording within this question appears to be derived from Bottom *et al.* (2005). These authors considered the problem of assessing the role of the Columbia River estuary in the decline and recovery of Pacific salmon. They concluded that the traditional approaches, which tended to consider the estuary merely as a physical locality through which salmon have to pass and, perhaps, suffer mortality, is inadequate. They therefore proposed an ecological framework that '*emphasizes the geographic structure of habitats, populations, and diverse salmon life histories that contribute to salmon resilience and productivity'*. The essential feature of this approach is to recognize that the ecological processes regulating population dynamics become linked across separate environments through the physical transport and migration of species with complex life cycles. While they recognize the value of this approach, Lindley *et al.* (2006) considered that VSP represents a broader and more general biological framework for considering the effects of proposed actions on salmon viability and recovery.

Lindley *et al.* (2006) reported that the fundamental improvement called for in the NMFS OACP-BiOp was a better-developed conceptual framework for analyzing the impacts of large-scale actions. The Cal-Fed reviewers suggested a 'life-cycle' approach, and Lindley *et al.* note that the general approach outlined by the McElhany *et al.* (2000) provides such a basis and is accepted by NMFS as best-available science.

Lindley *et al.* (2006) go on to suggest that the conceptual framework should have two major components. First, a biological conceptual framework is necessary to provide a context for integrating diverse types of scientific information into overall assessments of viability and risk at the population and ESU level. Second, a legal/policy conceptual framework could facilitate relating the biological conclusions regarding risk/viability to the legal concept of jeopardy. They note that within the framework provided by VSP, further improvements could be made by systematically examining all of the important linkages between project effects and VSP parameters, addressing climate variation and climate change, accounting for uncertainty, and making the connections between data, assumptions, analyses, and conclusions more transparent.

Consistent with the recommendations above, NMFS outlines the legal and biological frameworks in the KPO-BiOp and indicates that it has adopted the general life-cycle approach presented by McElhany *et al.* (2000) and '*uses the VSP as an organizing framework in the report to systematically examine the complex linkages between project effects and VSP parameters while also addressing key risk factors such as climate change and ocean conditions*' (p.30). This approach defines population viability on the basis of a specified probability of persistence in 100 years and evaluates VSP using four key population parameters: abundance; productivity; spatial structure; and diversity. However, although McElhany et al. (2000) provides a useful conceptual framework, it does not propose specific quantitative criteria that would allow for assessing the viability of specific populations. Williams et al. (2007) have therefore addressed the question of establishing population-specific criteria that could be developed to take into account differences in the

quantity or quality of freshwater habitat, variability in marine survival, or other conditions that influence viability. However, these authors note that for many populations of Pacific salmonids, including SONCC coho salmon, very little population-specific data are available and quantitative assessments may be impossible. Although the KPO-BiOp uses both these approaches, which potentially provide a sound framework for presenting information on the viability of the affected coho salmon populations, the relationship between the two approaches is not made very clear, and this creates confusion in the assessments as outlined below.

The description of the viability of SOCCC coho salmon in Section IV-B-4 is structured around the four key VSP parameters of McElhany *et al.* (2000) (p.42 *et seq*.). This section considers the status and critical habitats of SONCC coho salmon and outlines the population viability in the context, *inter alia*, of these VSP parameters. While this section presents the four to six guidelines for each of the key parameters that must be satisfied in order for an ESU to be considered viable (from McElhany *et al.),* it fails to provide a clear indication of the extent to which these guidelines have been met, and does not address the population-specific criteria considered by Williams *et al.* (2007) other than in relation to abundance. Some of the McElhany *et al.* guidelines have been discussed, but it is not clear whether the others have been ignored as a result of lack of information or for other reasons. As a result, while the evaluation is based on the VSP framework, the failure to address fully the guideline means the final assessment (p.48) that '*NMFS believes that the SONCC coho ESU is currently not viable'* appears incomplete. The authors may have taken the view that, since all the guidelines must be met for an ESU to be considered viable, they only need to demonstrate that one is not being met to show that the ESU is not viable. However, this does not provide a complete basis for assessing what might happen if conditions change.

A further assessment of the *Current Viability of Affected Klamath River Population Units* is provided in Section V-E (p.90), but this is based largely around Williams *et al.* (2007) rather than the McElhany *et al.* (2007) guidelines. In Section IV-B-4 it is noted that, *'Due to data limitations, Williams et al. (2007) were not able to assess the viability of the SONCC coho salmon ESU with the quantitative approach they proposed'*. However, in Section V-E it is proposed that, *'comparing rough population estimates...against population viability thresholds proposed by Williams et al. (2007) allow NMFS to make conservative assumptions concerning the viability of Klamath River … population units'*. This apparent inconsistency creates some confusion. Furthermore, although this section considers the viability of the five population units of Klamath River coho salmon affected by the Project it is not clearly structured to demonstrate the assessment for each population unit.

It is apparent that there are insufficient data available to provide a detailed geographical assessment of all available habitats, and Section V-D, *Habitat Conditions in the Action Area (p.76),* provides a broad description of the mainstem river which is structured around three large mainstem reaches, the Lower, Middle and Upper Klamath River Reaches. However, relatively little information is provided on the habitats in the others parts of the River Basin such as the main tributaries, despite the fact that movement between these habitats by salmon at different life-sages may be driven by differences in environmental conditions and may be critical to their survival.

The structure of this Section relating to the Upper River Reach (p.84 *et seq*.) could also be clarified. The Upper River Reach includes areas both upstream and downstream of Iron

Gate dam (IGD) despite the fact that these sections must be markedly different with respect to their impacts on Klamath River coho salmon and their current biological status. IGD represents a clear cut-off point in the current upstream distribution of coho salmon (and other migratory species), and the upstream section will only become accessible to these fish following the development of fish passes after 2014. As a result it would aid clarity and provide a basis for clearer linkages to other Sections of the report if these river sections were made more distinct and the geographic framework was based around four River Reaches, three below IGD and one above.

In the section '*Effects of the Action'* (Section VI, p.92 *et seq*.) the KPO-BiOp is structured around the three 'geographical units' described above, although the section headings (Upper Klamath Population Unit, the Middle Klamath River Reach and the Lower Klamath River Population Reach) suggest some confusion between geographic 'reaches' and biological 'population units'. [Also, somewhat perversely, they are presented in the opposite order to the previous habitat descriptions.] Since the Lower, Middle and Upper Klamath River Populations Units move between the respective geographic areas with the similar names, there is a need for some clarification of the biological and geographic areas/boundaries used in the report.

The impacts of the Project in each of these reaches/population units are then considered for three time periods within the year (Oct through Feb, March through June, and July through Sept) (p.95 *et seq*.). This provides a sound framework for considering the main effects on key life history stages occurring within this spatial and temporal matrix. While this is a logical and structured approach which can clearly demonstrates the complex interactions between habitat requirements at different life stages, it would be helpful to provide clearer cross linkages with the four key parameters used in other Sections for evaluating VSP, since these also provide the basis for assessing population viability in the final sections. It might also be helpful to use this matrix to provide a tabulated summary of the findings of this Section.

In Section IX, '*Integration and synthesis of the proposed action'*, (p.134 *et seq*.), NMFS seeks to '*evaluate whether predicted changes in the viability of Klamath River coho populations are expected to result from the proposed action and whether they will be sufficient to increase extinction risks of SONCC coho salmon at the ESU scale*'. This Section is structured around the main Population Units, including, in this case, two of the tributary populations. However, while it purports to address their viability, it makes little reference to the approaches of McElhany *et al.* (2000) or Williams *et al.* (2007), which have been used to assess viability previously. These changes in the structure adopted for different parts of the KPO-BiOp make it difficult to bring the strands of the report together and determine whether the assessment is sound.

In conclusion, the KPO-BiOp does utilize ecological frameworks that demonstrates the geographic structure of habitats, populations, and salmon life histories and relates these to the key parameters that define VSP. While this framework should provide a clear and sound basis for evaluating the potential impacts of the Project, its clarity must also depend on providing a clear account of the linkages as the different factors are discussed, and this is not always apparent within the KPO-BiOp.

b. Does the draft biological opinion consider a range of climatological conditions and water demand scenarios in the analysis?

Lindley *et al.* (2006) (p.7) report that both the Cal-Fed review and one of the CIE reviewers of the NMFS OACP BiOp considered that assuming that future climate will be like the recent past is unreasonable, because of the likely effects of global climate change on temperature and precipitation regimes. Lindley *et al.* agreed that the best available scientific information indicates that the global climate is warming, and that the effects might include hydrologic changes due to decreased snow fall and earlier snow melt. They further conclude that these trends increase the risk to protected populations, which can lead to optimistic risk assessments.

Climatological conditions

The issue of climatological conditions and climate change is first addressed in any detail in the KPO-BiOp in the context of factors responsible for historic SONCC coho salmon decline (p.38). This section briefly considers future trends in climatic conditions and notes that climate models '*diverge with respect to future trends in precipitation'*. But it indicates that there is agreement that the trends towards lower springtime snow water equivalent (SWE) and earlier snow melt will continue. However, the report does not quantify these likely trends in any way nor does it describe potential climate scenarios. Indeed it jumps straight to the conclusion that availability of water is likely to be most limited in the summer, without mentioning that the factors describe above may also affect spring flows and temperatures.

Section V-C includes climate change as one of the '*Activities Affecting SONCC Coho Salmon and their Critical Habitat in the Action Area*' (p. 67). However this Section (V-C-6) refers simply to negative impacts of climate change due to reductions in available freshwater habitat. In particular it is noted that adaptation of salmon populations to climatic change will be expected to lag behind that change; and the extent and speed of the change will also affect the ability of the population to adapt. However, no indication is given of the possible scale of this impact.

Climatic factors are acknowledged as a matter of concern at various points in the KPO-BiOp, with reference to: climate change as a risk factor (p.30); evidence that temporal changes in climate have affected volume and timing of snowmelt (p.34) and are likely to do so in the future (p.104); climate change as one of the possible causes of declines in tributary flow (p.59); likely effects of climatic warming on water demand for agriculture (p.59 and p.63); the probability that climatic factors will exacerbate the effects of limited habitat availability and releases of hatchery fish (p.69); ocean productivity being linked to climate variability (p.69); peak spring flows being advanced with reduced late spring accretions (p.104); dry warm conditions being likely to persist with increased climatological variability (p.112 and p.140); etc. However, in none of these cases are scenarios postulated that can be used to investigate the potential future affects of climatic change on the VSP assessment for Klamath population units.

On p.133 a study is described which simulated the effects of climate change on spatial and temporal temperature patterns but this study appears only to have considered historical data and provides only very general indications of future temperature trends or scenarios. There is also some indication that there are opposing views about likely effects of climate change.

This should not preclude the consideration of climatic scenarios but may mean that a wider range of alternatives have to be considered.

Water demand:

Various human activities are reported in the KPO-BiOp as having affected water demand in the Klamath River Basin in the past, including agriculture, forestry, mining, industry and domestic use. Major water diversion within the Klamath Project are shown in Section II-C (p.16) but this, and the following text on flow management, provide no indication of alternative scenarios for the future, although different demands are noted for different times of year (p.20) (i.e. variable F in equation 1.) Some activities in the river basin have now largely ceased (e.g. mining), but water demand from others is expected to continue to expand, including within the 10 year project period (e.g. from agriculture, p.59)). However the information provided on the extent and effects of possible increases in water demand are limited.

Reclamation has used the Water Resources Integrated modeling System (WRIMS) Model to attempt to simulate flows at Iron Gate Dam (IGD) and elevations for Upper Klamath Lake (p.19). However, this approach appears to be based entirely upon historic trends and variation, and it does not incorporate future changes in water demand. Furthermore, as indicated in Section III-E (p.33) in relation to the use of the WRIMS Model, all other existing non-reclamation actions influencing water availability appear to remain in place and constant for the analysis (p.34).

Section V-C-1 (p.58) briefly notes that the effects to coho salmon due to agriculture are expected to increase during the 10 year action period due to increased water demand, but no details are provided of the expected extent of the change or the mechanisms of the impact. Section V-C-2-c (pp.63-4) also appears to assume that increased water demand is inevitable and shows a linear trend in increasing water consumption by the Klamath Project from 1961 to 2000. But no attempt is made to project scenarios into the future despite the fact that the trends and variability in these data might provide a basis for making initial estimates of a range of future consumption scenarios.

While the analysis of '*Effects of the Action'* (Section VI, p.92 *et seq*.) considers low, average and high flows, this reflects annual variation in weather conditions and is not related to longer-term trends in climatic conditions or water demand, and these data cannot be said to present a range of climatological conditions and water demand scenarios

In conclusions, the KPO-BiOp makes it clear that both climatological changes and increased water demand pose significant risks to the future viability coho salmon population units in the Klamath River Basin. The report also indicates that changes in climatological conditions and water demand are likely in the coming years. However, the BiOp does not present alternative climatic options or quantify future changes in water use and does not consider a range of climatological conditions and water demand scenarios in the analysis or in the assessment of the Project.

c. Does the draft biological opinion consider a range of ocean conditions in the analysis?

Lindley *et al.* (2006) (p.8) report that the Cal-Fed reviewers considered that assuming that very recent ocean conditions will hold into the future was untenable. They note that NMFS' OACP-BiOp states that at least part of the recent upturns in abundance of chinook salmon is due to favorable conditions in the ocean. In spite of this recognition, the OACP-BiOp argued that populations will be able to bear long-term increases in mortality caused by the project because they have recently experienced short-term increases in abundance.

Lindley *et al.* (2006) conclude that the OACP-BiOp should have evaluated whether the populations will be able to bear the increased mortality under the full range of ocean conditions, which will include periods of poor survival as well as good periods. However, they recognize that it would not be easy to incorporate the suggested analyses in the short term, and suggest that BiOps should avoid arguing that anticipated impacts are sustainable on the basis of recent population performance, especially when that performance is suspected to be partly the result of favorable climatic conditions.

The KPO-BiOp recognizes the potential impact of ocean conditions on the Klamath River coho salmon populations (e.g. p.39) and notes, for example, that warm ocean regimes result in lower ocean productivity possibly leading to competition for food and density-dependent effects. The KPO-BiOp also notes that these effects may be exacerbated by competition between wild salmon and the large numbers of fish released from hatcheries (p.38), particularly since hatchery releases are not reduced to compensate for poor productivity years. Coupling of oceanic conditions with climate is also noted, but as indicated above (Section 4b of this report), the BiOp lacks information on possible climate change scenarios.

Despite the recognition of the importance of oceanic conditions and the uncertainties about future climatic trends, the KPO-BiOp does not explicitly consider the implications of alternative scenarios. For example it reports on a coho life cycle model that has been developed by Reclamation and used to predict the influence of water operations on the sustainability of Klamath Basin coho salmon. Although this model takes account of ocean productivity, one of its limitations is that it uses constant ocean and survival parameters throughout the duration of the 12 year model period. While this precludes considering the effects of environmental variability within the period, it might not prevent the model being used to compare the effects of different oceanographic conditions. However, it must be noted that the KPO-BiOp expresses reservations about the state of development of this model and does not use it within Section IX, *Integration and Synthesis.* [NB – Few details of the model are provided in the KPO-BiOp and the citation (Cramer Fish Science 2006) is not listed in the references].

In Section XI, oceanic conditions are recognized as being 'influential' to the variability of all populations within the SONCC coho salmon ESU (p.134), but alternative conditions are not included in the analysis. Ocean conditions are also considered briefly in the '*Viability Analysis of Historical Populations*' (Section XI-A), but only with respect to the Upper Klamath Population and Shasta River Population. Furthermore it only indicates a likely improvement in ocean conditions since 2007 and increased variability in the future (p.140 and p.144). It is also noted that, '*The most recent information suggests future cohorts (e.g. 2008 and beyond) may experience improved ocean conditions, and ocean survival is*

expected to improve' however the citation, 'NMFS, 2008', is not listed in the references. Since this appears to contradict the conclusions of Lindley et al. (2006), who consider that assuming that very recent ocean conditions will hold into the future is untenable, it clearly deserves more detailed consideration.

In conclusion, although the KPO-BiOp acknowledges the role of ocean conditions in affecting the viability of coho salmon population units with the Klamath River and notes the potential interactions with other factors, it does not consider a range of ocean conditions in the analysis.

d. Does the draft biological opinion consider the effects of hatchery fish on listed fish?

Lindley et al. (2006) report that the Cal-Fed reviewers of the OCAP-BiOp urged that the effects of hatchery fish be analyzed concurrently with the other project impacts. They indicate that the OCAP-BiOp says that hatcheries are '*interrelated and interdependent actions*' of the project that are intended to mitigate for habitat losses caused by the project. Lindley at al (2006) therefore conclude that it seems appropriate for a biological opinion to address the '*full range of impacts that hatcheries might impose on protected populations*'.

The KPO-BiOp reports that within the SONCC coho salmon ESU, the main stocks including the Klamath river stock, '*remain heavily influenced by hatcheries and have little natural production in mainstem rivers'* (p.36). It is also noted that '*the listing of SONCC coho salmon includes all within-ESU hatchery programs*', and reference to Federal Register (2005) indicates that this is probably because the hatchery programs are considered essential for the ESU's recovery. This creates some confusion with the above question, which appears to imply that 'hatchery fish' are separate to the 'listed fish'. Further to this, Williams *et al.* (2007) is cited as suggesting that the fraction of naturally spawning fish within a population that is of hatchery origin should not exceed 5% (p.91). The KPO-BiOp notes that this threshold is clearly exceeded in the case of the Klamath River, and therefore concludes that this would suggests that the Klamath River meta-population is at least at moderate risk of extinction with regard to genetic integrity. These apparent inconsistencies mean that the long-term objectives of the hatchery programs appear ambiguous and the implications for the further analysis of the effects of hatchery releases on the viability Klamath River coho salmon populations units are unclear and need to be explained more fully.

The potential impacts of hatchery releases on wild fish are outlined in more detail in Section IV-B-3 (p.37), and it is recognized that hatchery fish may contribute to the decline of natural populations. It is reported that spawning by hatchery salmonids in rivers and streams is often not controlled, and hatchery fish stray into rivers and streams transferring genes from the hatchery populations into naturally spawning populations Because hatchery programs generally alter the genetic composition, phenotypic traits and behavior of reared fish, the KPO-BiOp correctly observes that result of introgression of hatchery fish into natural spawning populations can be lower survival of the progeny and a reduction in the reproductive success of the natural stock..

However, hatchery releases can, of course, very significantly supplement the numbers of adult fish produced and spawners returning to the river. Thus, the KPO-BiOp cites Weitkamp *et al.* (1995), who combined run-size estimates for a number of water courses to

provide a rough minimum run-size estimate for the entire ESU of about 10,000 natural fish and 20,000 hatchery fish. This clearly indicates the significance of hatchery fish in the systems and their potential to significantly affect the natural population units.

Section IV-B-4 provides a more detailed assessment of the viability of the SONCC coho salmon, using the four key VSP parameters, and cites Federal Register (2005) as concluding that hatchery fish reduce the risk of extinction to some degree by contributing to increased ESU abundance and diversity but have a neutral or uncertain effect on productivity and spatial structure. However, this evaluation is based on a NMFS report which is not cited in the KPO-BiOp. Furthermore, on p.47 of the KPO-BiOp it is concluded that '*high hatchery production in these systems* [Trinity River, Klamath River and Rogue River] *may mask trends in ESU population structure and pose risks to ESU diversity*', thus apparently contradicting the Federal Register (2005) assessment.

There is also some uncertainty about the relative survival of hatchery and wild fish. For example, on p.57 a study is described which showed that survival of hatchery smolts is not different to natural smolts, although the results were uncertain. But elsewhere it is reported that hatchery smolts appear to migrate slower in the Upper Klamath River (p.106), that hatchery smolts show migration delays (p.113), and that some wild coho salmon smolts show 'rearing type behavior' (p.56 and p.113) (although rearing-type behavior is not defined). This appears to provide the basis for concluding that there are differences in behavior associated with hatchery rearing and that this could result in heightened disease risk, and thus reduced survival, within the mainstem Klamath River (p.130). These apparent inconsistencies deserve further clarification in the KPO-BiOp.

While the KPO BiOp provides frequent cross references to the role of hatchery fish in increasing competition for habitat, the possibility that this may consequentially result in increased impacts of flow and temperature modification on natural populations is not clearly articulated. Thus for example, the report indicates that releases of reared fish in mid May to late June may create particular problems with competition between hatchery and natural fish for food, space and refugia, and this may be exacerbated by releases of chinook salmon smolts into the Upper Klamath River at about the same time (p. 107). It is further recognized that the displacement of fish as a result of competition for habitat may itself expose them to greater risks (e.g. from predators) and they will frequently have to move to less favorable habitat. However, the effects on habitat availability and utilization are not quantified in a way that permits a full understanding of the implications of the Project. While this may reflect the lack of good data on juvenile salmon distribution and habitat utilization in the river, the general qualitative information provided makes it very difficult to assess the combined effects of different factors.

Particular problems with hatchery fish are reported to occur below hatcheries, where high spawning concentrations of hatchery fish can exacerbate problems caused by disease, etc. It appears that this will mean that reduced flows in these locations will increase the adverse impacts of hatchery fish. It is also noted that hatchery rearing will not only have negative effects on mainstem population units, but may also affect smaller population units within the tributaries because of hatchery origin adults straying into these tributaries to spawn and juveniles outmigrating from these tributaries to seek temperature refugia.

In conclusion, the KPO-BiOp does consider the effects of hatchery fish on the Klamath River Population Units, but there is lack of clarity about the objectives of the hatchery programs and the role of hatchery fish within the ESU. There are a number of inconsistencies in the information provided about hatchery reared fish, including the appropriate or desired level of hatchery rearing, the behavior of wild versus hatchery smolts and the effects of hatchery fish on key VSP parameters. Given the clear desire to restore natural coho salmon populations, and the risks posed by hatchery fish, further consideration should be given to the potential beneficial effects of substantially modifying the releases of hatchery reared fish.

e. Did NMFS' draft biological opinion present convincing scientific evidence about the spatial and temporal extent of young-of-year and juvenile coho salmon use and occurrence in the mainstem Klamath River?

The KPO-BiOp notes that there are very few data available on the distribution of coho salmon fry and juveniles within the Klamath River, particularly in the mainstem (e.g. p.93). After emergence from spawning gravels in the mainstem Klamath River or their natal streams into the main river, fry are said to '*distribute themselves upstream and downstream while seeking favorable rearing habitat*' (p.55). However, since the distribution and utilization of coho salmon spawning areas are also not described in any detail and the numbers of spawners in the mainstem Klamath River is said to be small (p.54), this provides only a very limited understanding of the distribution of fry. The KPO-BiOp also notes that further redistribution of these fish occurs in the fall as they seek stream areas conducive to surviving high winter flows (p.55), but no further information is provided on where they go.

As with the fry, few juvenile coho salmon are reported to have been seen in the Klamath River (p.56) Information on the distribution of parr is thus very limited, with observations on the extent of movements and where they may be located within the Klamath River being described in only very general terms. Limited information is provided on distribution of juvenile coho in the Lower Klamath River, this being based on observations of the use of off-channel habitat by the juvenile fish in non-natal tributaries on the Klamath estuary by Voight (2007) (p.78), but otherwise it appears to be assumed that mainstem rearing by juvenile coho in this part of the system is rare (p.79 and p.80). The evidence for this is unclear, and later in the report there appears to be a reference to coho salmon smolts, parr and fry utilizing the mainstem river in the Lower Klamath River Reach (p.125). Similarly references to juvenile salmon distribution in the Middle and Upper Klamath River are very general (e.g. p.91), although there are a number of references to parr migrating out of the major tributaries in search of suitable summer habitat. While it may be difficult to provide additional information based on good observations, these apparent inconsistencies need to be clarified.

As a result of this lack of good data, the KPO-BiOp considers the theoretical instream habitat needs of juvenile fish based on the simulation modeling reported by Hardy *et al.* (2006) (p.93). This approach uses literature-based habitat suitability criteria to quantify habitat availability for different species and has been used to determine the likely distribution of coho salmon fry and juveniles within the Klamath River. Although Hardy *et al.* (2006) note that '*no coho fry observational data were available for a comparison of modelling results to be made within the main stem Klamath River'* and that '*insufficient data currently exists to quantitatively assess validation of the habitat modeling results'*, they also conclude that '*the*

overall simulation results are valid based on empirical observations and discussion with resource agency personnel familiar with coho use within the mainstem Klamath and general life history traits of the species'. However, the KPO-BiOp reports that '*the habitat suitability criteria were validated using the limited empirical observations of coho fry and parr in the mainstem Klamath River'* (p.93). They therefore judge that the simulation results reflected the field observations in terms of general habitat use and distribution and were therefore suitable for use in the instream flow evaluations. The above may be selective quotations from these reports, but it is not clear whether the KPO-BiOp fully reflects and takes account of the uncertainties in these data.

The KPO-BiOp also cite an NRC review of Hardy *et al.* (2006) which suggests that while the report consolidated and advanced the state of knowledge…*'it is, like all models, an imperfect representation of reality*'. Since the simulation approach itself provides only an indirect representation of the actual distribution of fry and juveniles within the river, the question may be asked whether it provides a sound basis for assessing the impacts of the Project. However, NMFS are required to make use of the best available science and this is also one of the basic principles of the application of the precautionary approach. This provides a clear justification for using the Hardy *et al.* approach, but there is also a need to fully reflect the resultant uncertainties.

While using the approach of Hardy *et al.* (2006) may be accepted as an inevitable consequence of having limited observations of juvenile fish in the river, it would be helpful if the precise nature of the information that it provides was made more explicit. Thus it is unclear in some parts of Section VI, '*Effects of the Action'* (p.95 *et seq*.), whether information is based on known or estimated/inferred distributions of fry or parr. For example on p.104, the KPO-BiOp refers to '*how coho salmon utilize the entire Upper Klamath River reach of the mainstem throughout this entire time period*' [March through June]. However, it appears that this information must be based upon the assumed utilization of suitable habitat identified by means of the simulation approach not on observations of fish distributions as the wording seems to imply. This distinction means that the conclusions that may be drawn are different.

Similarly, the KPO-BiOp suggests that, '*Based on monitoring information, coho salmon are expected to be present in the Upper Klamath River reach beginning in mid-April'* (p.106). However, given previous comments about the lack of observational data, the true meaning of this statement (e.g. whether it refers to monitoring of juvenile fish or just the habitat features) is unclear. No reference is provided for the 'monitoring' program.

[NB This comment does not apply to all references to juvenile salmon distribution in Section VI because in a number of places the text refers to the distribution of juvenile coho salmon habitat rather than of the fish themselves.]

In conclusion, information on the distribution on fry and parr in the mainstem Klamath River is clearly very sparse. As a result the KPO-BiOp relies heavily on a habitat simulation approach (Hardy *et al.*, 2006) to determine the distribution of suitable habitat for these life-stages and to thereby estimate the impacts of the Project. While this approach is consistent with using the best available scientific information it clearly adds significantly to the uncertainty. This therefore needs to be made more explicit, and greater effort must be made to remove inconsistencies in the report.

f. Has the draft biological opinion adequately evaluated the potential effects of mainstem flows on the survivorship of coho smolts?

The movements of coho salmon smolts within the Klamath River basin are described in Section V-B-4 (p.55-7) which also addresses the habitat requirements for smolts before and during outmigration. However, the observations are patchy and in some cases behavior has been inferred rather than observed (e.g. p.56).

Section V-D addresses the '*Habitat Conditions in the Action Area'*, although references to habitat requirements of smolts are sparse. Thus coho salmon smolts are reported to '*typically migrate downstream and into the Klamath River estuary during April and May, and have largely outmigrated by July when water quality degrades and water temperature rises*' (p.79) (cited reference not in the reference list). In the Middle Klamath River, smolts are said to '*encounter water conditions that generally support high migration and rearing survival*' (p.83), and no information is provided on habitat conditions for smolts in the Upper Klamath River.

With respect to the Upper Klamath River, the effects of hydrological conditions are considered in Section VI, '*Effects of the Action'*, with respect to rearing habitat by life history stage, including smolts (p.104), as well as the specific effects on smolt outmigration (p.113). This section indicates that there may be adverse habitat conditions in the Upper Klamath River which may affect survival and this may be exacerbated by releases of hatchery fish during the smolt outmigration. However, there is little specific information on the flow conditions utilized by outmigrating smolts, although there are reports of tracking studies being undertaken which might provide such data. The KPO-BiOp also suggests that '*coho salmon smolt outmigrant leaving the Shasta River would appear to be at greatest risk to survival in the Upper Klamath River reach*' (p.114) although the reason for this is not clear and does not appear to be explained.

The report acknowledges that increased flow at IGD should reduce transit time for outmigrating smolts and thereby increase their survival in the Upper Klamath River (p.114). It is also noted that Project Operations may '*result in a small delay to coho smolt outmigration'* and that this may increase risks of disease. However, there is little indication of the expected scale of these effects or the specific flow rates at which they might occur; this therefore make it difficult to relate these assessments to the operational plans for the Project.

With respect to the Middle Klamath River, the KPO-BiOp reports that smolts '*move relatively quickly through the … Reach, pausing little to rear during their downstream journey*' (p.121), and that '*lower habitat volume under above average* [flow] *years would likely have small effect on the overall survival rate of wild coho salmon smolts migrating downstream in March, April and May, since wild coho salmon smolts are thought to migrate quickly through the Middle Klamath River Reach*' (p.122). However, it also suggested that '*smolts and parr will be competing for available habitat with hatchery-released salmon and steelhead beginning in April*', and this '*likely peaks during May and June'* (p.122). It is also recognized that flow rates '*can influence migration rates and disease spore concentrations, both of which can influence infection incidence and severity'* (p.123). These apparent inconsistencies do not appear to be resolved in the KPO-BiOp and there is no specific consideration of smolts in Section IX, '*Integration and Synthesis of the Proposed*

Action', relating to the Middle Klamath River Population. As a result the potential effects of mainstem flows on the survivorship of coho smolts in the Middle Klamath River Reach is not clearly explained or fully evaluated.

Although the Lower Klamath River is clearly a migration corridor for all Klamath River smolts, there appears to be no information specifically on smolt movements or survivorship in this section of the mainstem river provided in Section VI, '*Effects of the Action*' (p 125-6) or Section IX, '*Integration and Synthesis of the Proposed Action*'; this may be because there are not thought to be any impediments to smolt movement but this is not made clear. However, as discussed by Bottom *et al.* (2005) in relation to the role of the Columbia River estuary in the decline and recovery of Pacific salmon, it is inadequate to consider the estuary merely as a physical locality through which salmon have to pass and, perhaps, suffer mortality. It seems most likely that smolts from Population Units throughout the system will exhibit variable holding and migrating behavior in the Lower Klamath River which may be affected by conditions both within this reach and upstream.

Further information is provided on smolt outmigration in relation to the area upstream of IGD (p 126), which is currently inaccessible to coho salmon. This Section refers to contradictory observation about the speed of smolt migration with respect to flows, with one study (Giorgi *et al.*, 2002) reporting that increased flows generally result in faster migration speeds, but another (Beeman, 2008) study suggesting increased transit times (p.130). I have not read these references and it is not clear whether the studies between them might indicate that there are optimum flows to facilitate smolt outmigration as might be expected. It is surprising, however, that these findings are not reported in the Sections of the KPO-BiOp relating to other Klamath River Reaches.

In conclusion, the KPO-BiOp contains specific Sections describing hydrological effects on smolts in different Klamath River Reaches, but relatively little information is provided in some of these Sections and some of it appears to be contradictory. Since smolt outmigration is clearly a critical phase in the coho salmon lifecycle, it requires more detailed evaluation.

g. Are the draft biological opinion's scientific findings on the influence of mainstem flows on the spatial and temporal extent of coho juvenile survivorship in the summer months scientifically supportable?

[NB – It should be noted that this review is not required to consider whether NMFS's conclusions regarding the Project's potential to adversely modify of destroy critical habitat or jeopardize the continued existence or recovery of listed SONCC coho salmon are correct and this question is addressed in this context. (See Annex 1 - SOW)]

As indicated above, the KPO-BiOp acknowledges that data on the spatial and temporal distribution of juvenile coho salmon within the mainstem Klamath River is sparse. As a result, information on the utilization of different river reaches by different life-history stages has largely had to be inferred from simulation modeling which uses knowledge of the habitat requirements of these life-stages to estimates the availability of suitable habitat within the river. Subsequent to this, the influence of mainstem flows on the spatial and temporal extent of coho juvenile survivorship has had to be estimated principally on the basis of the impacts on of the Project on the estimated habitat availability. While this is a legitimate approach, it

is clear that it introduces considerable uncertainty into the assessment, which is often not explicitly recognized within the KPO-BiOp.

Within the Upper Klamath River reach below IGD, it is recognized that rearing opportunities in the summer months will be limited by excessive water temperatures, and juvenile salmon therefore seek out thermal refugia. However, the relationship between river flows and temperatures and the consequent effects on the volume of refugia is not clearly or quantitatively described. It therefore appears that IGD flows will affect the extent of these refugia, but the report does not attempt to quantify the effects of different flows to determine how conditions may be optimized. Instead it concludes (based on two cited studies but without providing any details) that a base flow of 1000cfs is expected to provide sufficient flow to both maintain the integrity and connectivity to the limited thermal refugial zones available to juvenile coho salmon in the Upper Klamath River reach.

As in the Upper Klamath River reach, juvenile coho salmon occurring in the Middle Klamath River reach in the summer months are thought to seek out thermal refugia, particularly at tributary mouths and within the lower reaches of the tributaries as river temperatures increase. Thus, after July, the number of juvenile coho within the mainstem is thought to be greatly reduced, either because the fish die as a result of competition for limited space or because they move into cooler water areas. However, as noted above, the relationship between river flows and water temperature within the mainstem and the effects on the volume of suitable thermal refugia is not described in any detail, making it difficult to assess the effects of the Project. Instead the KPO-BiOp reports first that proposed flows are believed to be sufficient to allow free movements between tributary and mainstem habitat, although the basis of this assessment is not very clear given the paucity of information on juvenile salmon distribution in the river. It also notes that coho utilization of thermal refugia in the mainstem Middle and Lower Klamath reaches appears to be uncommon, based on lack of observation of these fish in studies of the refugia, although this seems to been an oversimplification of the information on juvenile salmon distribution presented elsewhere and discussed above. On this basis the KPO-BiOp concludes that the anticipated flows will not significantly impact coho salmon parr within the Middle Klamath Reach, but it is difficult to see that this conclusion is well-founded.

Little reference is made to the impacts of flow on juvenile salmon in the Lower Klamath River during the summer, presumably because few such fish are thought to be present at that time.

In conclusion, information on the spatial and temporal distribution of juvenile salmon in the mainstem Klamath River is very limited and, as discussed in other sections, has largely had to be inferred from simulation modeling of suitable habitat. While this provides a basis for assessing the possible effects of different flow conditions on juvenile coho survival, the full effects of different flow regimes on the quantity and quality of available habitat have not been fully assessed or clearly presented.

5 Conclusions

The Terms of Reference for this review pose seven questions which are addressed individually in subsection 4a to 4g above, and concluding comments have been provided at the end of each subsection.

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ANNEX 1 Statement of Work

External Independent Peer Review by the Center for Independent Experts

Assessment of NMFS' Draft Biological Opinion on the Bureau of Reclamation's Klamath Project Operation

Project Background:

The purpose of this independent review is to evaluate and comment on the use of the best available scientific and commercial information in our draft biological opinion concerning effects of the Bureau of Reclamation's (Reclamation's) Klamath Project Operations (Project) on the listed threatened Southern Oregon/Northern California coast (SONCC) coho salmon (*Oncorhynchus kisutch*) and its designated critical habitat for the period of 2008 through 2018. The review will focus on the technical aspects of the NMFS draft biological opinion; the review will not determine if NMFS' conclusions regarding the project's potential to adversely modify or destroy critical habitat or jeopardize the continued existence or recovery of listed SONCC coho salmon are correct.

Due to water limitations to meet all the needs of humans, wildlife and fisheries resources, NMFS' 2001 and 2002 biological opinions on the effects of the Bureau of Reclamation's Klamath Project Operation (Project), including water deliveries to the Klamath Irrigation Project, have been subject to intense scrutiny and litigation. In an effort to ensure we correctly analyzed the effects of the Project, NMFS sought review from the National Academies Committee on Endangered and Threatened Fishes in the Klamath River Basin (NRC) on the strength of scientific support for the biological assessment and biological opinion.

The NRC released its 2002 Interim Report on NMFS' 2001 biological opinion and their conclusions included: ·

- A lack of evidence indicating high mainstem flows influence coho year class strength. ·
- The relative increase in available habitat for coho salmon in the mainstem Klamath River resulting from higher flows required in NMFS' Reasonable and Prudent Alternative to the Proposed Action were minor. ·
- A lack of scientific evidence in the Klamath River of a positive relationship between mainstem Klamath River flows and coho smolt survivorship. ·
- Higher summer flows could be disadvantageous by further increasing water temperature and reducing available thermal refugial habitat in the mainstem Klamath River.

Following the release of NMFS' 2002 biological opinion on the Project for the period 2002-2012, the NRC released their Final Report on Endangered and Threatened Fishes in the Klamath River Basin (2004) in which the above conclusions were reiterated and additional information and recommendations for the continued survival of Klamath River coho salmon were provided.

Coincident to the NRC's review and recommendations, NMFS sought peer review on its Central Valley Project and State Water Project Operations, Criteria, and Plan (OCAP) biological opinion. NMFS asked the CalFed Bay–Delta Authority Science Program (CBDA) and the Center for Independent Experts (CIE) each to conduct independent peer reviews to evaluate whether the scientific information used in the biological opinion was the best available. The peer review reports raised multiple and complex issues that merited evaluation in the context of future improvements to NMFS' biological opinions on large-scale projects (*i.e.*, OCAP, Klamath Project Operations). In response to the OCAP reviews, NMFS' Science Center developed recommendations and guidance for the development of future NMFS biological opinions. NMFS' Science Center Review (Lindley *et al.* 2006) includes recommendations to improve the conceptual framework of section 7 analyses on large-scale projects. NMFS has in hand a general life cycle approach outlined by the Viable Salmonid Populations (VSP) report (McElhaney *et al.* 2000). VSP is accepted by NMFS as best available science. Lindley *et al.* (2006) concluded that within the framework provided by VSP, further improvements could be made by systematically examining all of the important linkages between project effects and VSP parameters, addressing climate variation and climate change, accounting for uncertainty, and making the connections between data, assumptions, analyses, and conclusions more transparent.

New Information:

NMFS' draft biological opinion will utilize the body of new scientific information on coho salmon in the Klamath River. This information includes (1) SONCC Technical Recovery Team documents defining the historical population structure of Klamath River basin coho salmon (Williams *et al.*. 2006), and population viability (Williams *et al.*. 2007); (2) Cramer Fish Sciences Klamath River Coho Life Cycle Model; (3) Evaluation of Instream Flow Needs in the Lower Klamath River Phase II Final Report (Hardy *et al.*. 2006) ; (4) Reclamation's Undepleted Natural Flow Study Final Report (Reclamation 2005); (5) NRC's Review of Hardy *et al.*. 2006, and Reclamation 2005; (6) new information on the effects of mainstrem flow and water quality on fish disease; and (7) other information provided in Reclamation's final biological assessment (2007). The breadth of new information includes disparate conclusions relevant to the potential effects of the Project on coho salmon and NMFS will need to reconcile these disparate conclusions in our draft biological opinion.

Overview of CIE Peer Review Process:

The Office of Science and Technology implements measures to strengthen the National Marine Fisheries Service's (NMFS) Science Quality Assurance Program (SQAP) to ensure the best available high quality science for fisheries management. For this reason, the NMFS Office of Science and Technology coordinates and manages a contract for obtaining external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of stock assessments and various scientific research projects. The primary objective of the CIE peer review is to provide an impartial review, evaluation, and recommendations in accordance to the Statement of Work (SoW), including the Terms of Reference (ToR) herein, to ensure the best available science is utilized for the National Marine Fisheries Service management decisions.

The NMFS Office of Science and Technology serves as the liaison with the NMFS Project Contact to establish the SoW which includes the expertise requirements, ToR, statement of

tasks for the CIE reviewers, and description of deliverable milestones with dates. The CIE, comprised of a Coordination Team and Steering Committee, reviews the SoW to ensure it meets the CIE standards and selects the most qualified CIE reviewers according to the expertise requirements in the SoW. The CIE selection process also requires that CIE reviewers can conduct an impartial and unbiased peer review without the influence from government managers, the fishing industry, or any other interest group resulting in conflict of interest concerns. Each CIE reviewer is required by the CIE selection process to complete a Lack of Conflict of Interest Statement ensuring no advocacy or funding concerns exist that may adversely affect the perception of impartiality of the CIE peer review. The CIE reviewers conduct the peer review, often participating as a member in a panel review or as a desk review, in accordance with the ToR producing a CIE independent peer review report as a deliverable. The Office of Science and Technology serves as the COTR for the CIE contract with the responsibilities to review and approve the deliverables for compliance with the SoW and ToR. When the deliverables are approved by the COTR, the Office of Science and Technology has the responsibility for the distribution of the CIE reports to the Project Contact.

Requirements for CIE Reviewers:

The CIE shall provide three independent scientists to conduct an independent peer review; this review will be conducted as a desk review and no travel is required. Expertise is required in water manipulation and management, instream flow and salmonid habitat modeling, application of the Endangered Species Act, salmonid population risk assessment methodologies, and conservation biology. Each reviewer's duties shall not exceed a maximum of 7 days to conduct the literature review, peer review, and completion of the CIE peer review report in accordance to the Terms of Reference (ToR).

Statement of Tasks for CIE Reviewers:

The CIE reviewers shall conduct necessary preparations prior to the peer review, conduct the peer review, and complete the deliverables in accordance with the ToR and milestone dates as specified in the Schedule section.

Prior to the Peer Review: The CIE shall provide the CIE reviewers contact information (name, affiliation, address, email, and phone) to the Office of Science and Technology COTR no later than the date as specified in the SoW, and this information will be forwarded to the Project Contact.

Pre-review Documents: Approximately two weeks before the peer review, the Project Contact will send the CIE reviewers the necessary documents for the peer review, including supplementary documents for background information. The CIE reviewers shall read the pre-review documents in preparation for the peer review.

CIE reviewers shall review the following document which is the focus of the questions listed above:

1. NMFS' Draft Biological Opinion on Bureau of Reclamation's Klamath Project Operations 2008-2018.
2. To aid the reviewers, copies of relevant documents cited in this statement of work will be provided.

The above material will be provided by the NMFS Southwest Regional's (SWR) Project Contact.

This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process. Furthermore, the CIE reviewers are responsible for only the pre-review documents that are delivered to them in accordance to the SoW scheduled deadlines specified herein.

Desk Peer Review:

The primary role of the CIE reviewer is to conduct an impartial peer review in accordance to the ToR herein, to ensure the best available science is utilized for the National Marine Fisheries Service (NMFS) management decisions (refer to the ToR in Annex 1).

The itemized tasks for each reviewer consist of the following.

1. Read the draft biological opinion with a focus on the effects analysis.

2. Consider additional scientific information as necessary.

3. The CIE reviewers shall conduct an independent peer review and complete an independent peer-review report addressing each task in accordance to the Terms of Reference with a copy each sent to Dr. David Die at ddie@rsmas.miami.edu and Mr. Manoj Shivlani at shivlanim@bellsouth.net.

Each report is to be based on the individual reviewer's findings, and no consensus report shall be accepted.

Terms of Reference

CIE reviewers shall evaluate the draft Opinion to determine whether the following questions resulting from the Science Center review are adequately addressed:

h. Does the draft biological opinion incorporate an ecological framework that emphasizes the geographic structure of habitats, populations, and diverse salmon life histories that contribute to salmon resilience and productivity (*i.e.*, VSP concept, see McElhaney *et al.* 2000 and Lindley *et al.* 2006)?
i. Does the draft biological opinion consider a range of climatological conditions and water demand scenarios in the analysis?
j. Does the draft biological opinion consider a range of ocean conditions in the analysis?
k. Does the draft biological opinion consider the effects of hatchery fish on listed fish?

Additionally, CIE reviewers shall evaluate the draft biological opinion to determine whether the following questions resulting from the NRC's 2002 and 2004 reports are adequately addressed:

l. Did NMFS' draft biological opinion present convincing scientific evidence about the spatial and temporal extent of young-of-year and juvenile coho salmon use and occurrence in the mainstem Klamath River?
m. Has the draft biological opinion adequately evaluated the potential effects of mainstem flows on the survivorship of coho smolts?
n. Are the draft biological opinion's scientific findings on the influence of mainstem flows on the spatial and temporal extent of coho juvenile survivorship in the summer months scientifically supportable?

Schedule of Milestones and Deliverables:

5 March 2008	CIE shall provide the COTR with the CIE reviewer contact information, which will then be sent to the Project Contact
5 March 2008	The Project Contact shall send the CIE Reviewers the pre-review documents
19 March 2008	Each reviewer shall submit an independent peer review report to the CIE
2 April 2008	CIE shall submit draft CIE independent peer review reports to the COTRs
11 April 2008	CIE shall submit final CIE independent peer review reports to the COTRs
15 April 2008	The COTRs shall distribute the final CIE reports to the Project Contact

Submission and Acceptance of Deliverables (CIE Reports):

Upon review and acceptance of the CIE reports by the CIE Coordination and Steering Committees, CIE shall send via e-mail the CIE reports to the COTRs (William Michaels William.Michaels@noaa.gov and Stephen K. Brown Stephen.K.Brown@noaa.gov) at the NMFS Office of Science and Technology by the date in the Schedule of Milestones and Deliverables. The COTRs will review the CIE reports to ensure compliance with the SoW and ToR herein, and have the responsibility of approval and acceptance of the deliverables. Upon notification of acceptance, CIE shall send via e-mail the final CIE report in *.PDF format to the COTRs. The COTRs at the Office of Science and Technology have the responsibility for the distribution of the final CIE reports to the Project Contacts.

Key Personnel:

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Request for Changes:

Requests for changes shall be submitted to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the Contractor within 10 working days after receipt of all required information of the decision on substitutions. The contract will be modified to reflect any approved changes. The Terms of Reference (ToR) and list of pre-review documents herein may be updated without contract modification as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToR are not adversely impacted.

ANNEX 1

REPORT GENERATION AND PROCEDURAL ITEMS

1. The report shall be prefaced with an executive summary of comments and/or recommendations.

2. The main body of the report shall consist of a background, description of review activities, summary of analyses and comments, and conclusions/recommendations.

3. The report shall also include as separate appendices the bibliography of materials reviewed and a copy of the statement of work.